Mid-Atlantic Paleosols and Plio-Pleistocene Paleoclimate

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DEPARTMENT OF EARTH AND ENVIRONMENTAL SCIENCES

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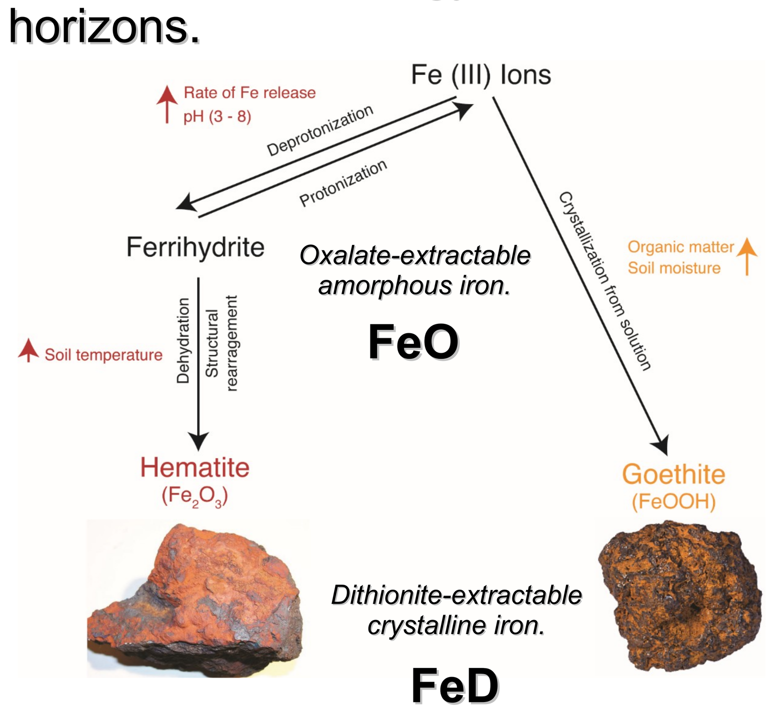
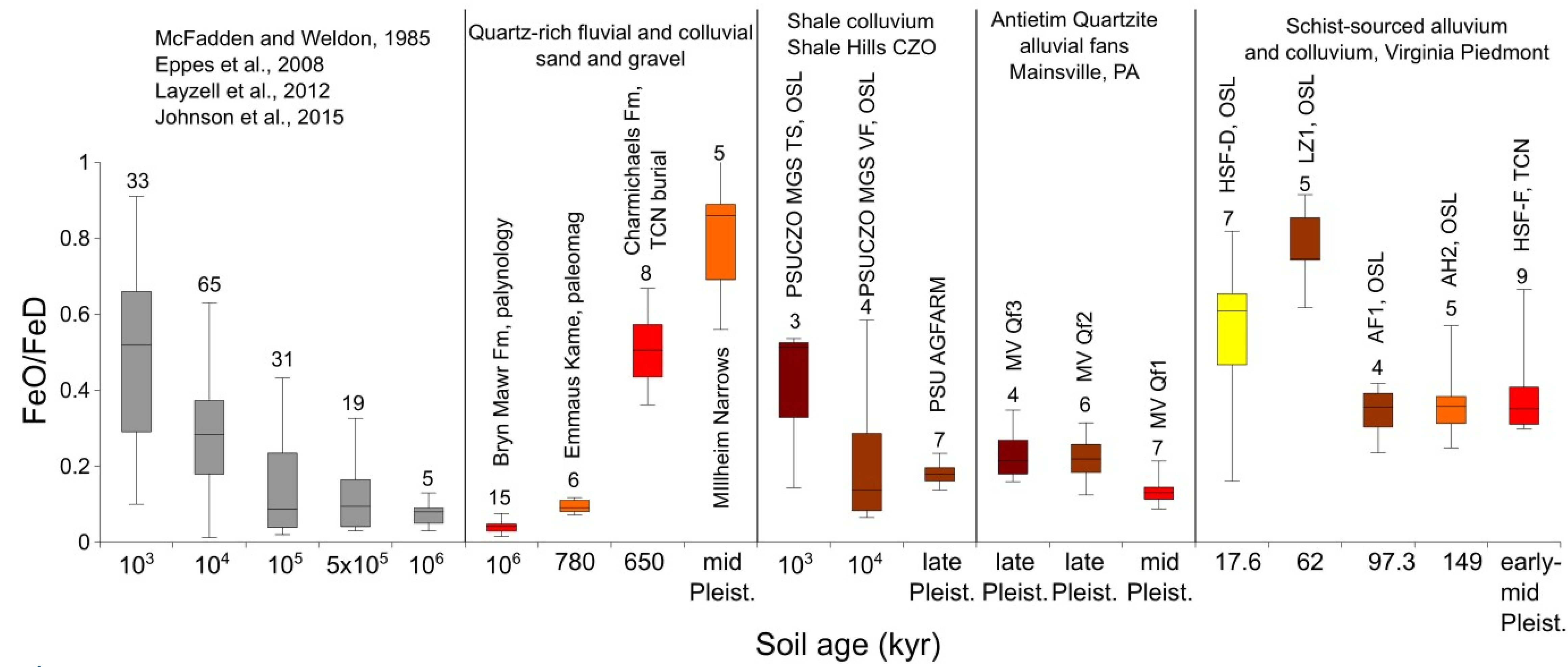
1. Colluvial and alluvial soils in Pennsylvania and throughout the mid-Atlantic region commonly show a brown, presumably late Pleistocene-Holocene surface soil above a red paleosol that presumably formed under different environmental conditions. We are testing this long-held interpretation using OSL and TCN geochronology and Fe mineralogy of the B-horizons.



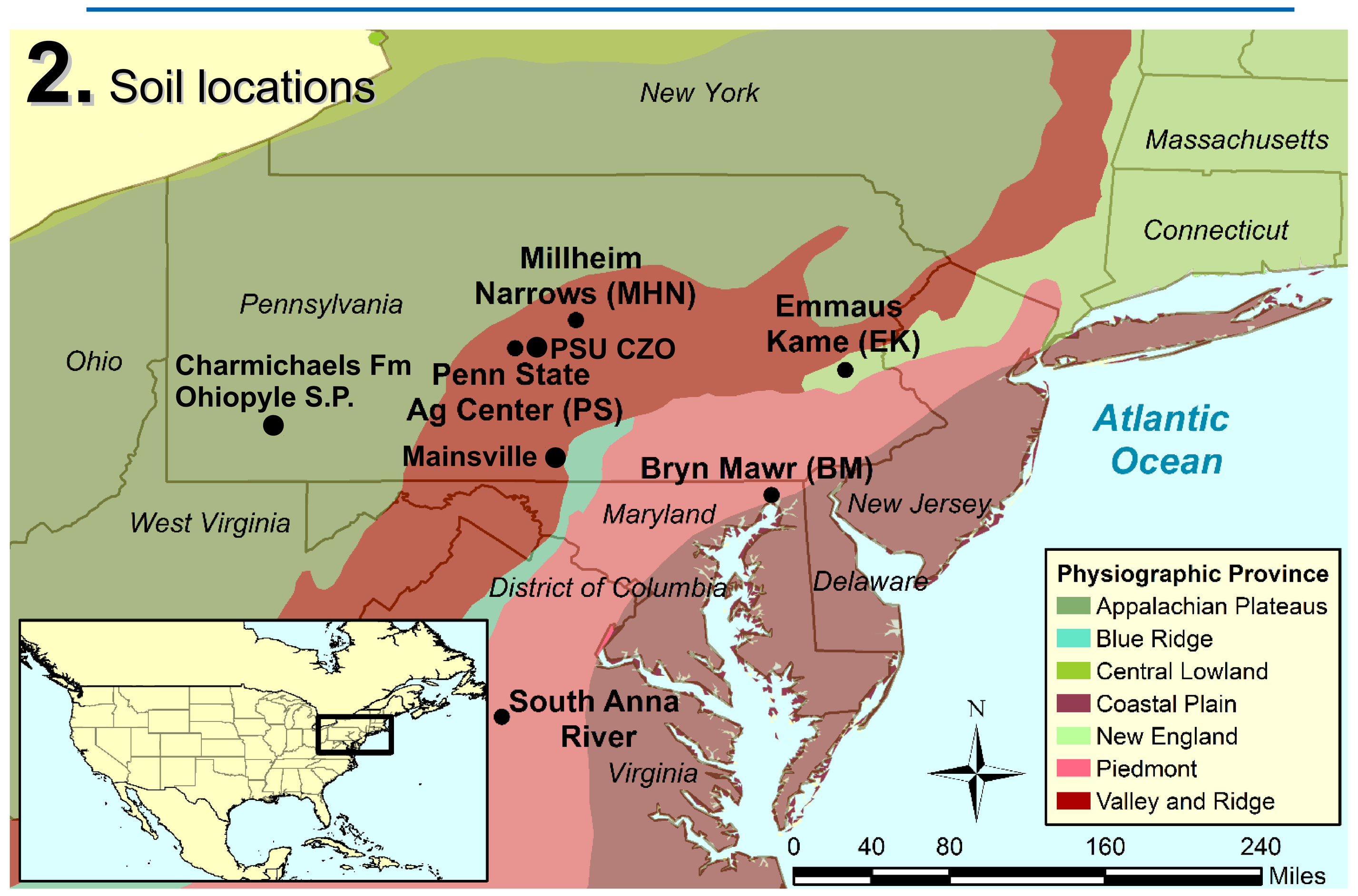
McKeague and Day (1966); Mehra and Jackson (1960)

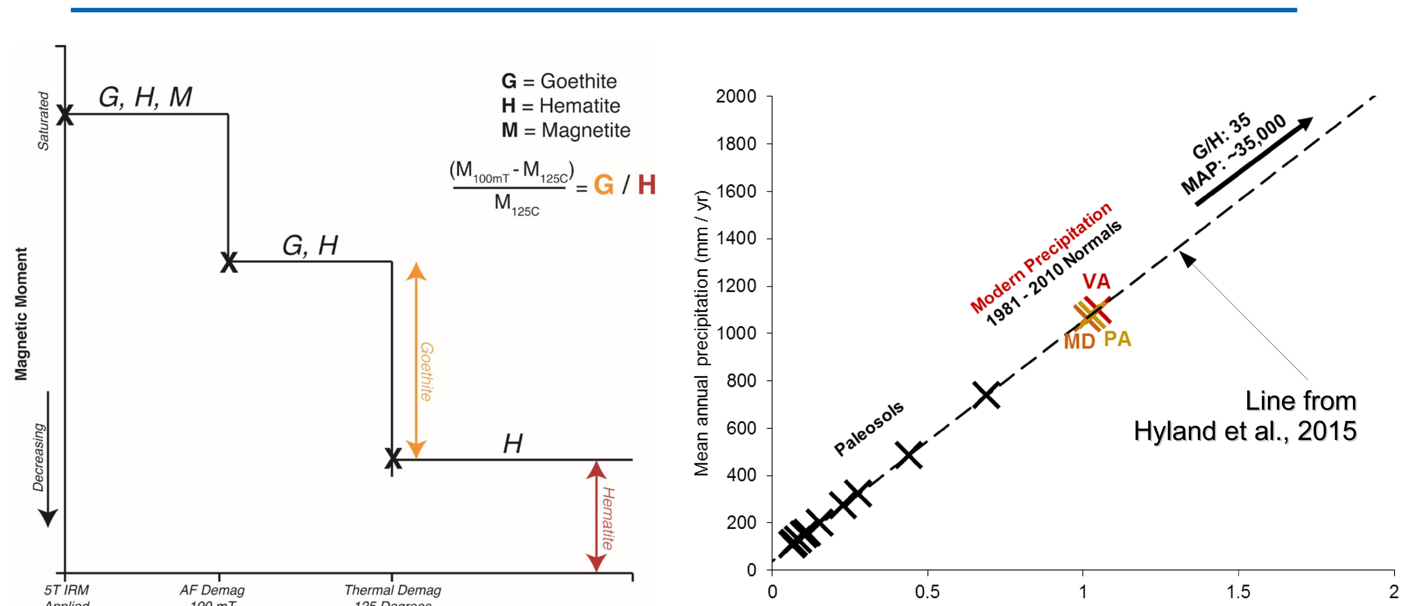
Millheim Narrows soil



4. Box and whisker plot comparing FeO/FeD ratio of OSL and TCN dated paleosols (parent material) in the mid-Atlantic region to a global compilation from the literature. Older soils are expected to have more crystalline iron, and therefore smaller FeO/FeD ratios. Notable soils that do not meet this expectation are at Millheim Narrows and the Charmichaels Fm alluvium at Ohiopyle State Park. Soils of the Virginia Piedmont lack a clear trend with age.

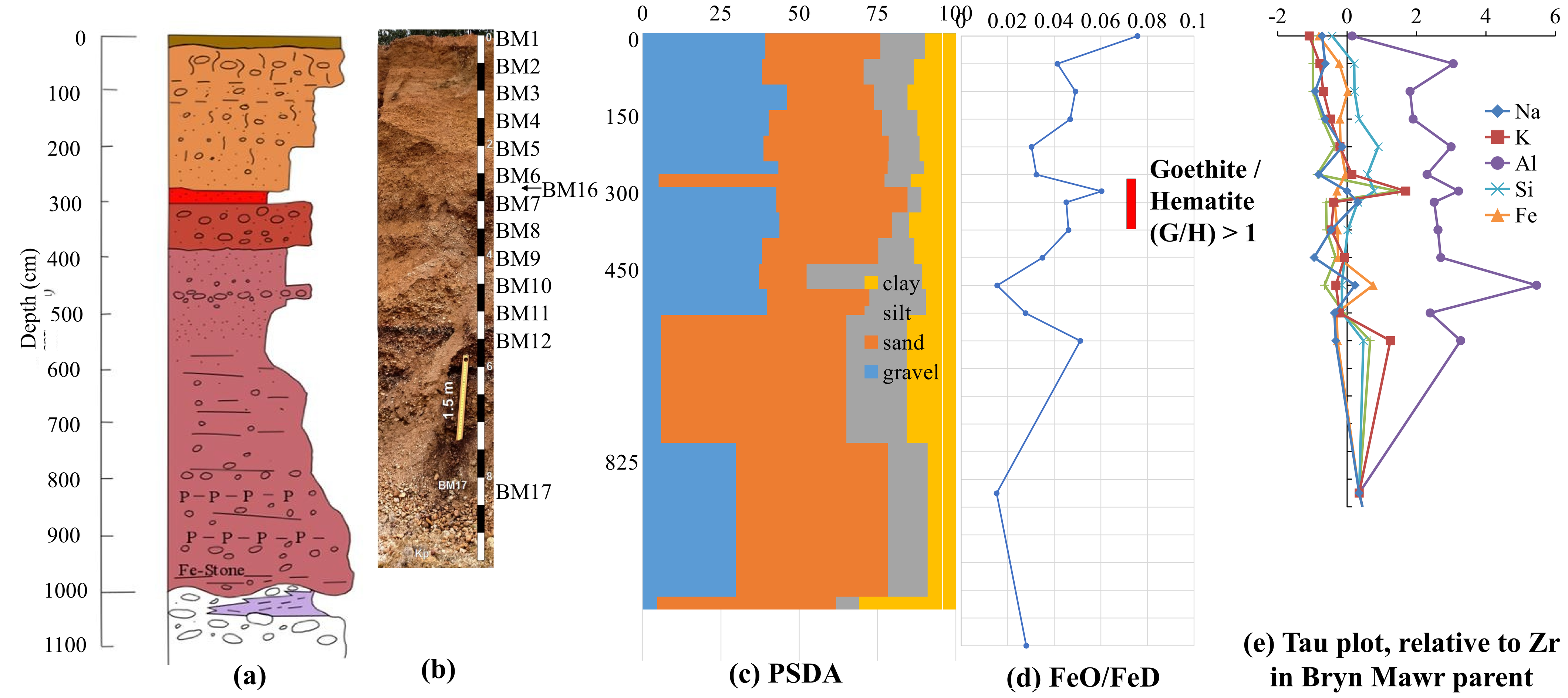
2. Soil locations





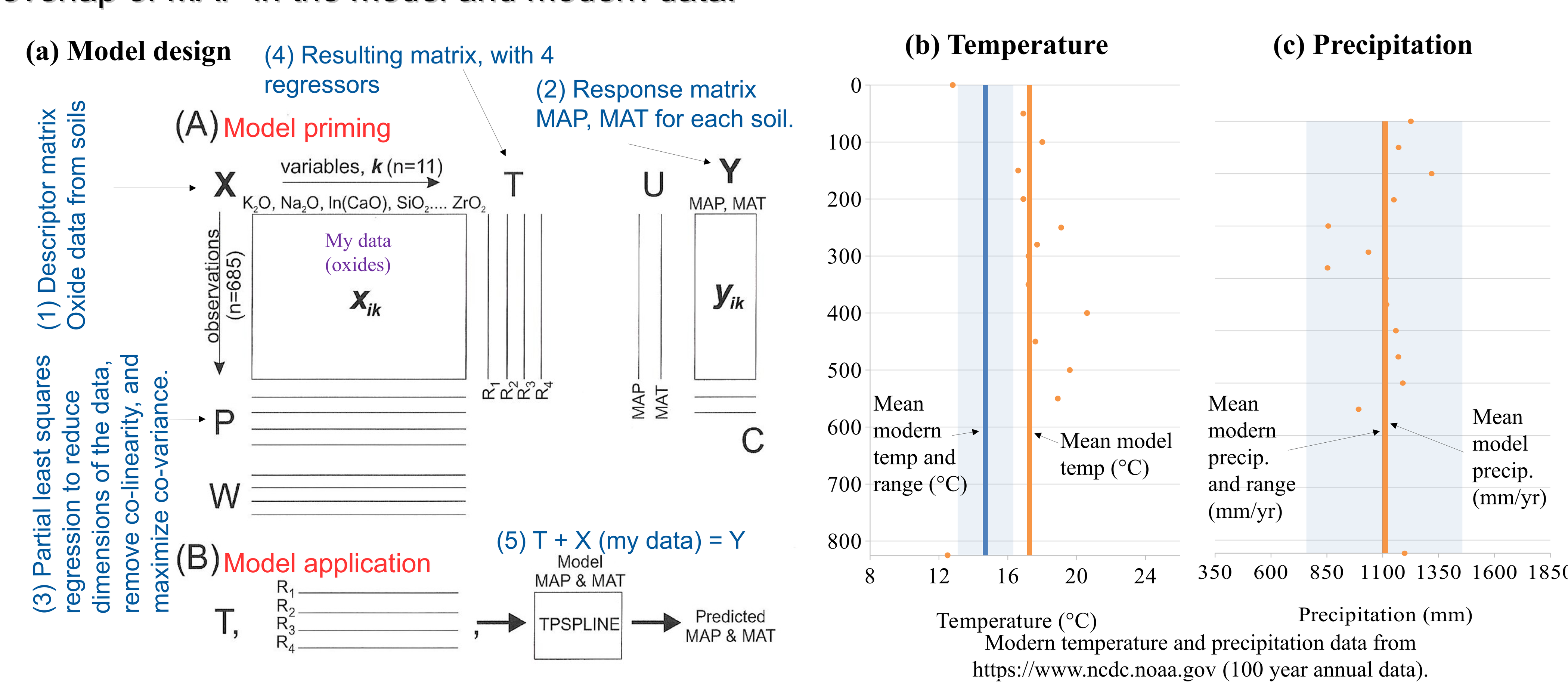
3. Iron crystalline species can be determined using paleomagnetic techniques. A recent study (Hyland et al., 2015) suggests that the goethite to hematite (G/H) ratio in the B-horizons of modern soils strongly correlates with mean annual precipitation. The mean G/H ratios of nearly all of our paleosol B-horizons uniformly indicate drier conditions during pedogenesis. The G/H ratio of the Bryn Mawr Fm (Mio-Pliocene) paleosol indicates pedogenesis under much wetter than present conditions.

Example of soil chemistry modeling – the Bryn Mawr Fm paleosol

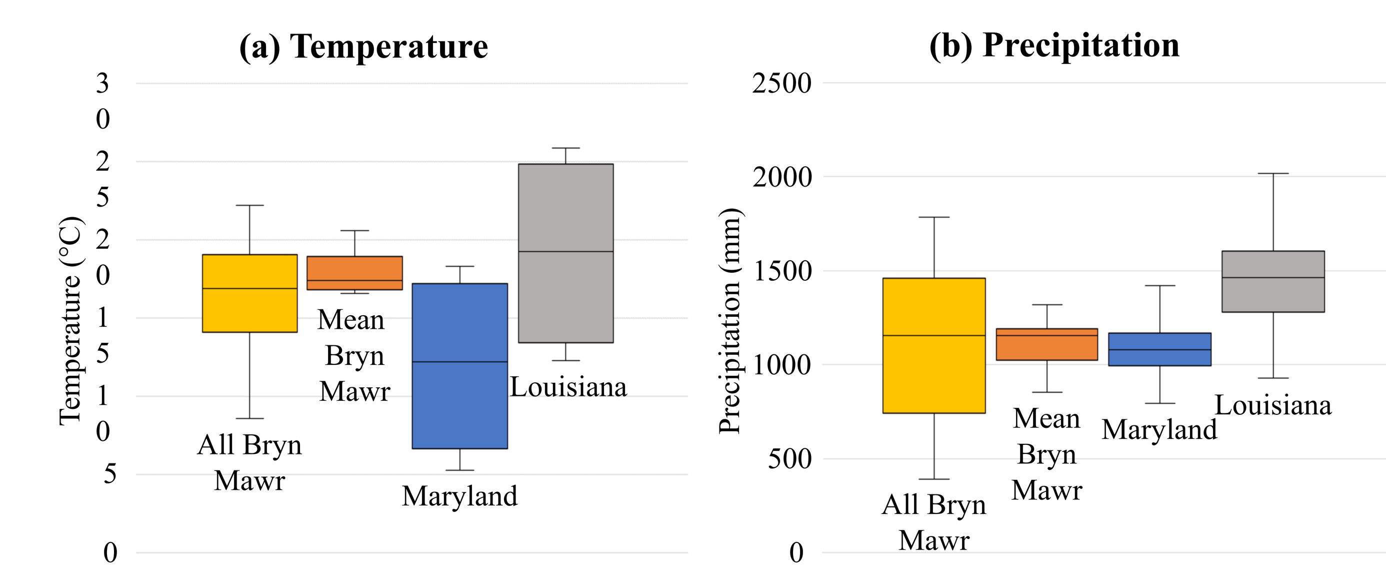


5. ***above*** **(a)** Bryn Mawr Fm lithostratigraphy and **(b)** photo of sampled section, **(c)** PSDA data, **(d)** Fe-chemistry, and **(e)** tau plot based on major elemental analysis. The mean grain size is ~0.4-0.5mm and composed almost entirely of quartz. Note Al enrichment in **(e)**.

6. ***below*** **(a)** Data-driven, multi-parameter spline model of Stinchcomb et al. (2016, AJS) showing (A) how the model is primed with oxide data and (B) applied, resulting in model **(b)** MAT and **(c)** MAP. Note vertical shading that denotes modern MAT and MAP for Cecil County, MD and the overlap of MAP in the model and modern data.



Modern temperature and precipitation data from https://www.ncdc.noaa.gov (100 year annual data).



7. Model predicted Bryn Mawr **(a)** MAT and **(b)** MAP compared to modern day Maryland and Louisiana MAT and MAP from 1900-2016. Bryn Mawr data includes maximum and minimum MAT and MAP model predictions. Modern data is compiled from annual values from NOAA.gov.

Conclusions

- Soil chemistry reflects all of the soil forming factors (climate, organisms, relief, parent material, and time); our study attempts to see the climate signal in these data.
- Results collectively suggest that the main geochemical properties of the Bryn Mawr soil were locked into the profile in the Tertiary, and that Tertiary climate was at least as wet, and probably warmer than present for the mid-Atlantic region.
- Pleistocene red paleosols indicate drier than present conditions consistent with their red (hematite) colors.
- Dispersion in the FeO/Fed ratios requires further study.

References and Acknowledgments

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